Chapter 2
Measurements

True/False Questions

1. Standard notation is an expression of a number using powers of 10.
   False; Easy

2. 0.000411 is an example of using standard notation to express a number.
   True; Easy

3. Meter is the SI unit of measuring length of an object.
   True; Easy

4. The multiplicative amount of the prefix nano is one thousand.
   False; Easy

5. Volume of a vessel is measured using a derived unit.
   True; Easy

6. One cubic centimeter is equal to a milliliter.
   True; Easy

7. Significant figures represent the limits of what values of a measurement or a calculation we are sure of.
   True; Easy

8. Any nonzero digit in a measurement is considered significant.
   True; Easy

9. Zeros at the end of a number without a decimal point are considered significant.
   False; Easy

10. The number '0.006608' has six significant figures.
    False; Easy

11. The number '8.6090×10^{3}' has only four significant figures.
    False; Easy

12. The following calculation is performed with the proper number of significant figures. $124 \times 10.45 = 1290$
    True; Moderate

13. As per the 2010 census, the United States population is estimated to be 308.70 million. This measurement has four significant figures.
    False; Moderate

14. If the operations being performed are multiplication or division, the answer has to be limited to the number of significant figures that the data value with the most number of significant figures has.
    False; Easy

15. The number 9.666×10^6 has four significant figures.
True; Easy

16. If the expression X+Y=Z is valid, 10X+10Y=10Z is also valid.
True; Easy

17. Conversion factor refers to a fraction that can be used to convert a quantity from one unit to another.
True; Easy

18. 555 nm is equivalent to 0.555 mm.
False; Moderate

19. An exact number is a measured value of an estimate or a calculation.
False; Easy

20. Temperature is a measure of the average amount of static energy a system contains.
False; Easy

21. On the Fahrenheit scale, the freezing point of liquid water is 32°F, and the boiling point of water is 212°F.
True; Easy

22. 0°F is equivalent to -32°C.
False; Moderate

23. 30°C is the Celsius equivalent of 86°F.
True; Moderate

24. Density is a physical property that is defined as a substance's mass divided by its volume.
True; Easy

25. A ball made of iron has a mass of 3.78 g. If the density of the ball is 7.87 g/cm^3, the volume of the cork is $2.08cm^3$.
False; Moderate

Multiple Choice Questions

26. The straightforward expression of a number is referred to as _____ notation.
    a. standard
    b. scientific
    c. exponential
    d. technical
    e. methodical
    a; Easy

27. _____ notation is an expression of a number using powers of ten.
    a. Standard
    b. Customary
    c. Technical
    d. Scientific

e. General

d; Easy

28. Identify the scientific notation of 698.
    a. 6.98×10^{1}
    b. 6.98×10^{2}
    c. 6.98×10^{3}
    d. 6.98×10^{-2}
    e. 6.98×10^{-3}

    b; Easy

29. The exponent's value in scientific notation is equal to:
    a. the power of ten the base number is multiplied by.
    b. the number of odd decimal digits in the number expressed in standard notation.
    c. the number of digits after the decimal point in the number expressed in standard notation.
    d. the number of even decimal digits in the number expressed in standard notation.
    e. the number of digits in the number expressed in standard notation.

    a; Easy

30. What does a negative exponent of a number imply?
    a. The number is imaginary.
    b. The number's value is less than one.
    c. The number is irrational.
    d. The number cannot be expressed as a fraction.
    e. The given number is a negative number.

    b; Easy

31. The part of a number in scientific notation that is multiplied by a power of 10 is called the _____.
    a. exponent
    b. numerator
    c. association
    d. coefficient
    e. denominator

    d; Easy

32. Which of the following unit systems is commonly used in chemistry?
    a. FTS system of units
    b. United States customary units
    c. International System of Units
    d. British system of Units
    e. System of imperial units

    c; Easy

33. Which of the following is the SI unit of length?
    a. Meter
    b. Feet
    c. Yard
    d. Inch
    e. Mile

a; Easy

34. Which of the following is a fundamental SI unit?
    a. Yard
    b. Kilogram
    c. Feet
    d. Minute
    e. Joule
    b; Easy

35. Which of the following is an example of a numerical prefixed SI unit?
    a. Pound
    b. Gram
    c. Yard
    d. Second
    e. Centimeter
    e; Easy

36. Fifteen kilometers is equal to _____.
    a. 1500 meters
    b. 150 meters
    c. 150000 meters
    d. 15000 meters
    e. 0.00015 meters
    d; Easy

37. Which of the following parameters is measured using a derived SI unit?
    a. Length
    b. Weight
    c. Volume
    d. Time
    e. Perimeter
    c; Easy

38. Joule (J) is the unit of energy or work in the International System of Units. A joule can be represented as $J = kg \times m^2 \div s^2$. Joule is a(n) _____.
    a. Prefixed unit
    b. Fundamental unit
    c. Derived unit
    d. Imperial unit
    e. FTS unit
    c; Easy

39. One liter is _____ of a meter cubed.
    a. 1/1000th
    b. 10^{th}
    c. 100^{th}
    d. $1/100^{th}$
    e. $1/10^{th}$
    e; Easy

40. Which of the following is measured using a derived SI unit?
    a. Area of a circular plate
    b. Perimeter of metal ring
    c. An individual's mass
    d. Time taken to boil water
    e. Diameter of a ball
    a; Easy

41. The concept of reporting the proper number of digits in a measurement or a calculation is called _____.
    a. derived units
    b. prefixed units
    c. imprecise representation
    d. loose depiction
    e. significant figures
    e; Easy

42. Significant figures represent the limits of _____.
    a. human ability to approximate the value of a calculation
    b. what values of a measurement or a calculation we are sure of
    c. the inaccuracy displayed by a measuring instrument
    d. the population of data used to arrive at a certain conclusion
    e. methods used to calculate the accuracy of a calculation
    b; Easy

43. Which of the following statements is true about the significance of numbers?
    a. Zeros between non-zero digits are not considered significant.
    b. All digits of a number are significant, though their relative importance vary.
    c. Zeros at the end of a number without a decimal point are significant.
    d. Leading zeroes serve only to put the significant digits in the correct positions.
    e. Zeros at the end of any number with a decimal point are significant.
    e; Easy

44. Which of the following zeros is not significant?
    a. Zeros at the end of a number without a decimal point
    b. Leading zeros of a decimal number
    c. Embedded zeros in a decimal number
    d. Trailing zeros of a decimal number
    e. Zeros at the beginning of a decimal number
    b; Easy

45. How many significant figures does the measurement '0.00030033' have?
    a. 1
    b. 3
    c. 4
    d. 5
    e. 8
    d; Moderate

46. Which of the following measurements has 3 significant figures?
    a. 3670.05

b. 50505
c. 0.06067
d. 0.000060
e. 8.00×10^2

e; Easy

47. For the calculation given below, express the final answer to the proper number of significant figures.
$1.23 + 18.788 = ?$
a. 20.018
b. 20.02
c. 20.03
d. 20.029
e. 20.02180

b; Moderate

48. For the calculation given below, express the final answer to the proper number of significant figures.
$56.8003 - 50.1 = ?$
a. 6.701
b. 6.702
c. 6.7
d. 6.71
e. 6.7003

c; Moderate

49. For the calculation given below, how many significant figures should the result have?
$505 \div 5.8030 = ?$
a. 1
b. 2
c. 3
d. 4
e. 5

c; Easy

50. For the below given calculation, express the final answer to the proper number of significant figures.
$5.8003 \times 20.0 = ?$
a. 116
b. 116.1
c. 116.01
d. 116.006
e. 116.0060

a; Moderate

51. How many significant figures does the number '3.303×10^6' have?
a. 5
b. 6
c. 10
d. 7
e. 4

e; Easy

52. How many feet are there in 15 yards?
    a. 45
    b. 75
    c. 5
    d. 10
    e. 30
    a; Easy

53. Expressions used to formally change the unit of a quantity into another unit are called _____.
    a. natural expressions
    b. denominators
    c. dimensions
    d. conversion factors
    e. fundamental ratios
    d; Easy

54. Which of the following terms refers to formally changing the unit of a quantity into another unit?
    a. Fundamental analysis
    b. Unit prefixing
    c. Numerical prefixing
    d. Signifying numbers
    e. Factor label method
    e; Easy

55. Identify the value associated with the prefix milli.
    a. 1/100
    b. 1/1000
    c. 100
    d. 1000
    e. 0.01
    b; Easy

56. What is the liter equivalent of 55.12 μL?
    a. 55120
    b. 5512
    c. 5.512×10^{-5}
    d. 5.512×10^{-2}
    e. 5.512×10^{2}
    c; Moderate

57. How many cubic centimeters are in 0.1 m^3?
    a. 1000
    b. 100
    c. 10
    d. 10000
    e. 100000
    e; Moderate

58. Which of the following results is equivalent to 59.9 m/min?
    a. 599 cm/s
    b. 5.99 cm/s
    c. 998 cm/s
    d. 99.8 cm/s
    e. 5990 cm/s
    d; Moderate

59. Fifteen mm/s equals _____ m/min.
    a. 9
    b. 0.15
    c. 0.9
    d. 1.5
    e. 0.015
    c; Moderate

60. 35. How many nanoseconds are in 577.99 ms?
    a. 5.7799×10^{-8}
    b. 5.7799×10^{2}
    c. 5.7799×10^{5}
    d. 5.7799×10^{8}
    e. 5.7799×10^{9}
    d; Moderate

61. A(n) _____ number is a number from a defined relationship that technically has an infinite number of significant figures.
    a. natural
    b. exact
    c. complex
    d. irrational
    e. fundamental
    b; Easy

62. A square plot has sides of length 567 cm each. What is the area of the garden plot in square meters? Express your answer in the proper number of significant figures.
    a. 32.1
    b. 22.68
    c. 32.148
    d. 22.69
    e. 32.149
    a; Easy

63. _____ is a measure of the average amount of energy of motion, or kinetic energy, a system contains.
    a. Pressure
    b. Conductivity
    c. Temperature
    d. Density
    e. Viscosity

c; Easy

64. The _____ scale is a temperature scale where 0 degree is the freezing point of water and 100 degree is the boiling point of water.
    a. Celsius
    b. Fahrenheit
    c. Kelvin
    d. Newton
    e. Delisle
    a; Easy

65. What is 105.4°F in degrees Celsius?
    a. 38.65°C
    b. 40.79°C
    c. 36.24°C
    d. 39.66°C
    e. 40.78°C
    e; Easy

66. The _____ temperature scale uses degrees that are the same size as the Celsius degree, but the numerical scale is shifted up by 273.15 units.
    a. Rankine
    b. Fahrenheit
    c. Kelvin
    d. Newton
    e. Delisle
    c; Easy

67. What is the equivalent of 38°C in Kelvin scale?
    a. 100.15 K
    b. 311.15 K
    c. 300.15 K
    d. 105.15 K
    e. 101.15 K
    b; Moderate

68. Which of the following refers to absolute zero temperature in the Celsius scale?
    a. 150°C
    b. 273.15°C
    c. 295°C
    d. -273.15°C
    e. -295°C
    d; Moderate

69. _____ is a physical property that is defined as a substance's mass divided by its volume.
    a. Dynamic viscosity
    b. Density
    c. Kinematic viscosity
    d. Viscoelasticity
    e. Pressure
    b; Easy

70. What is the mass of 40.0 mL of mercury (density 13.6 g/mL)?
    a. 1436
    b. 2449
    c. 544
    d. 556
    e. 2941
    c; Easy

Essay Questions

71. What is the difference between standard notation and scientific notation?
    Standard notation is the straightforward expression of a number. Numbers such as 17, 101.5, and 0.00446 are expressed in standard notation. For relatively small numbers, standard notation is fine. However, for very large numbers, such as 306,000,000, or for very small numbers, such as 0.000000419, standard notation can be cumbersome because of the number of zeros needed to place nonzero numbers in the proper position. Scientific notation is an expression of a number using powers of 10. Powers of 10 are used to express numbers that have many zeros. It is suitable for very large and very small numbers.
    Easy

72. The time taken for a chemical reaction is estimated to be 0.00004 ms. How do you express this measurement, in seconds, using the scientific notation? What are the benefits of doing this?
    Here the measurement is expressed using the standard notation. Scientific notation allows you to write very large and small numbers quickly and compactly. This low value measurement can be expressed in scientific notation as 4×10^{-8} s.
    Moderate

73. Identify the numbers that are not written in proper scientific notation. Rewrite them, if incorrect, so that they are in proper scientific notation.
    a. 88.92×10^{3}
    b. $9{,}943 \times 10^{-5}$
    c. 5.88399×10^{5}
    The first two numbers are not written in proper scientific notation. They can be rewritten as shown below.
    a. 8.892×10^{4}
    b. 9.943×10^{-2}
    c. The third number is in proper scientific notation.
    Moderate

74. Briefly describe the International System of Units.
    The International System of Units or SI system of units specifies certain units for various types of quantities, based on seven fundamental units for various quantities. Some of the important fundamental units are meter for length, seconds for time, and kg (or kilogram) for mass. SI also defines a series of numerical prefixes that refer to multiples or fractions of a fundamental unit to make a unit more conveniently sized for a specific quantity.
    Easy

75. What are derived units? Explain by providing an example.

SI system of units allows for derived units based on a fundamental unit or units. There are many derived units used in science. For example, the derived unit for area comes from the idea that area is defined as width times height. Because both width and height are lengths, they both have the fundamental unit of meter, so the unit of area is meter × meter, or meter^2 (m^2). This is sometimes spoken as "square meters." A unit with a prefix can also be used to derive a unit for area, so we can also have cm^2, mm^2, or km^2 as acceptable units for area.
Easy

76. Provide examples of any three multiplicative prefixes and their multiplicative amounts.
Students may list any three of the following.

Prefix	Abbreviation	Multiplicative Amount
giga-	G	1,000,000,000 ×
mega-	M	1,000,000 ×
kilo-	k	1,000 ×
deci-	d	1/10 ×
centi-	c	1/100 ×
milli-	m	1/1,000 ×
micro	μ	1/1,000,000 ×
nano-	n	1/1,000,000,000 ×
pico-	p	1/1,000,000,000,000 ×

Easy

77. Explain the concept of significant figures.
The concept of reporting the proper number of digits in a measurement or a calculation is called significant figures. Significant figures (sometimes called significant digits) represent the limits of what values of a measurement or a calculation we are sure of. The convention for a measurement is that the quantity reported should be all known values and the first estimated value.
Easy

78. List the conventions that dictate which numbers in a reported measurement are significant and which are not significant.
(a) Any nonzero digit is significant.
(b) Any zeros between nonzero digits (i.e., embedded zeros) are significant.
(c) Zeros at the end of a number without a decimal point (i.e., trailing zeros) are not significant; they serve only to put the significant digits in the correct positions. However, zeros at the end of any number with a decimal point are significant.
(c) Zeros at the beginning of a decimal number (i.e., leading zeros) are not significant; again, they serve only to put the significant digits in the correct positions.
Easy

79. Explain how significant figures are handled in calculations.
Handling of significant figures depends on what type of calculation is being performed. If the calculation is an addition or a subtraction, the rule is as follows: limit the reported answer to the rightmost column that all numbers have significant figures in common. If the operations being performed are multiplication or division, the rule is as follows: limit the answer to the number of significant figures that the data value with the least number of significant figures has.

Easy

80. How are conversions from one unit to another unit of the same type performed?
Conversion factors are fractions that can be used to convert a quantity from one unit to another. These factors are used to coverts units from one unit to another of the same type. For example, 1 yard = 3 feet. So the conversion factor for feet to yards is 1/3. Feet can be converted to yards by multiplying with 1/3. Yards can be converted to feet by multiplying with 3.
Easy

81. How many millimeters are in 13.66 m? Explain the calculation and creation of conversion factor.
To answer this, one needs to construct a conversion factor between millimeters and meters and apply it correctly to the original quantity. The definition of a millimeter is as follows.

1 mm	= 1/1,000 m
1,000 mm	= 1 m
The conversion factor	= 1000
13.66m	= 13.66 ×1000
	= 13660mm

Moderate

82. What is an exact number? Explain with an example.
An exact number is a number from a defined relationship that technically has an infinite number of significant figures. An exact number is a number from a defined relationship, not a measured one. For example, the prefix kilo means 1,000 exactly, no more or no less.
Easy

83. What is temperature? What is the commonly used temperature scale in the United States?
Temperature is a measure of the average amount of energy of motion, or kinetic energy, a system contains. Temperatures are expressed using scales using units called degrees, and there are several temperature scales in use. In the United States, the commonly used temperature scale is the Fahrenheit scale. On this scale, the freezing point of liquid water (the temperature at which liquid water turns to solid ice) is 32°F, and the boiling point of water (the temperature at which liquid water turns to steam) is 212°F.
Easy

84. Explain the Celsius scale. Compare and contrast the Celsius scale with the Kelvin scale.
The Celsius scale (°C) is a temperature scale where 0°C is the freezing point of water and 100°C is the boiling point of water; the scale is divided into 100 divisions between these two landmarks and extended higher and lower.
The fundamental unit of temperature in SI is the kelvin (K). The Kelvin temperature scale uses degrees that are the same size as the Celsius degree, but the numerical scale is shifted up by 273.15 units. That is, the conversion between the Kelvin and Celsius scales is as follows:
K = °C + 273.15
°C = K − 273.15
Moderate

85. What is density? How is it measured?

Density is a physical property that is defined as a substance's mass divided by its volume:

$$\text{density} = \frac{\text{mass}}{\text{volume}} \text{ or } d = \frac{m}{V}$$

Density is usually a measured property of a substance, so its numerical value affects the significant figures in a calculation. Density overall has derived units. Common units for density include g/mL, g/cm^3, g/L, kg/L, or even kg/m^3.
Moderate

Fill in the Blanks

86. 0.00443 is the _____ notation of the number 4.43×10^{-3}.
standard; Easy

87. A(n) _____ is the raised number to the right of a 10 indicating the number of factors of 10 in the original number.
exponent; Easy

88. The part of a number in scientific notation that is multiplied by a power of 10 is called the _____.
coefficient; Easy

89. SI specifies certain units for various types of quantities, based on seven _____ units for various quantities.
fundamental; Easy

90. 10^{-9} is the multiplicative amount of the prefix _____.
nano; Easy

91. A(n) _____ is a unit that is a product or a quotient of a fundamental unit.
derived unit; Easy

92. _____ refers to the limit of the number of places a measurement can be properly expressed with.
Significant figures; Easy

93. Compute and express each answer with the proper number of significant figures.
1.234 + 65.3010 = _____.
66.535; Moderate

94. The number 90,000, when written in scientific notation with significant figures becomes _____.
9×10^4; Moderate

95. A(n) _____ is a fraction that can be used to convert a quantity from one unit to another.
Conversion factor; Easy

96. 5×10^5 nm is equal to _____ meters.
5×10^{-4}; Easy

97. A(n) _____ is a number from a defined relationship that technically has an infinite number of significant figures.
Exact number; Easy

98. _____ is a measure of the average amount of kinetic energy a system contains.
Temperature; Easy

99. The minimum possible temperature, labeled 0 K, is called _____.
absolute zero, Easy

100. _____ is a physical property that is defined as a substance's mass divided by its volume.
Density; Easy